Gail Purvis

Respiratory syncytial virus (RSV) sends about 120,000 children to the hospital in the US each year. Although it is only life-threatening in one case out of every 100, it infects virtually all children by the age of five. RSV also attacks the elderly, causing some 17,000 to 18,000 deaths yearly. Individuals with impaired immune systems are also highly susceptible. Worldwide, the virus causes about 1m deaths annually.

QDs fast detection of respiratory viral infections

Currently three methods of detecting RSV take from two to six days, postponing instant effective treatment. The new, high-tech method uses multi-colored quantum dots, which bind to molecular structures on the virus' coat and the cells that it infects.

Vanderbilt University researchers report that a QD system can detect the presence of particles of RSV in a matter of hours, rather than days. It is also more sensitive, allowing earlier virus detection.

When an RSV infects lung cells, it leaves part of its coat on the cell's surface. QDs have been linked to antibodies keyed to structures unique to RSV's coat. When dots come in contact with either viral particles or infected cells they stick to the surfaces.

"The problem with current detection technologies is that they take too long," says Pediatrics Professor, James E Crowe, Jr, who collaborated with Assoc. Professor of Chemistry David W Wright in the development. "When a patient with a respiratory illness comes in to the doctor, sometimes their symptoms are caused by bacteria, some times by viruses. There are specific medicines to treat some viral infections and there are definitely antibiotics to treat bacteria. Yet current detection tests take up to five days to tell if a virus is present and another day or so to tell which virus it is."

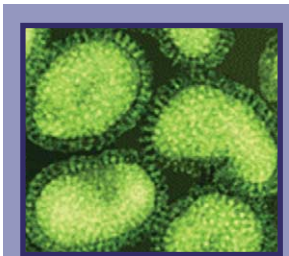

Image of Influenza virus A & B courtesy of "Viral Infections and Asthma." Sebastian L Johnston, Professor of Respiratory Medicine, National Heart and Lung Institute

Crowe lists three potential benefits for such an early detection system. It can:

- Increase the proper use of antiviral medicines. These are not used often because they are only effective if given early. By the time current tests identify the virus, it can be too late for antivirals to work.
- Reduce the inappropriate use of antibiotics. Antibiotics prescribed for respiratory illness are only of use if the infection is caused by bacteria. An early virus detection method would eliminate anti-biotic-resistance developing in bacteria.
- Allow hospital personnel to isolate infectious RSV patients from other patients, especially those susceptible to infection.

As it is easier to get approval for a new diagnostic test than a new drug, the researchers estimate that it will take only (!) two to three years to develop and validate the new test. "All the components are off-the-shelf," Wright adds, "so anyone can put together one of these detection systems if they want to."

It should also be relatively inexpensive. The most costly ingredients are the QDs: A small bottle that contains enough material for about 200 tests costs $300. This could be one of the earliest medical applications of nanotechnology, say Wright and Crowe.

The researchers' next step is to develop a QD cocktail capable of simultaneously detecting the presence of at least five major respiratory viruses: influenza A and B, para-influenza and metapneumovirus, in addition to RSV. Wright and Crowe demonstrate that they can use two different colours of QDs simultaneously. The coloured QDs are attached to different 'linker' molecules that bind to different RSV surface structures.

"QDs are available in a dozen different colors, and antibodies specific to the other four respiratory viruses have been identified and can be used as linker molecules. Such a test would be able to diagnose more than 90% of all the cases of viral respiratory infection," says Crowe. "The existence of such a test could encourage development of improved therapies for respiratory viruses. Without a good diagnostic for a specific viral infection, drug companies don't have motivation to develop effective treatments."

Currently, three diagnostic tests are available for identifying respiratory viruses. The 'gold standard' involves incubating an infected sample in a tissue culture for five days, using a fluorescent dye to test for the virus presence. The problem with this is the virus is multiplying in the patient, as it grows in the culture. This has led hospitals to switch to real time polymerase chain reaction, which is extremely sensitive, but takes 36-48hrs and needs highly trained molecular biologists in reference laboratories. The antigen test takes 30 minutes but is not sensitive enough to detect the the virus at the early stages of an infection. Another QD advantage is that they maintain their brightness for hours. The QD method takes an hour or two and is even more sensitive than real time PCR. "It can detect the presence of RSV within an hour after the virus is added to a culture," says Wright.

Source: http://exploration.vanderbilt.edu/news/news_quantum.htm